ARMY RESEARCH LABORATORY

Low Cost Sensor Technology for Future Targeting Systems

John S. Eicke

U.S. Army Research Laboratory

John Eicke, 301-394-2620

935

It is likely that the sensor technology community can provide the future Army fire support elements with indigenous low cost, high performance, targeting sensors.

John Eicke, 301-394-2620

Questions

- What are the targets & what are their characteristics ?
- What sensors are available ?
- How can those sensors be emplaced ?
- How can those sensors be employed ?

John Eicke, 301-394-2620

What Are Targets

- **Ground Vehicles**
  - Tanks, APC's, Trucks,
- **Aircraft**
  - Helicopters, UAV's, fast movers
- **Personnel**
  - Moving, Talking, Other activities
- **Weapon Firings**
  - Artillery, Missiles, Mortars
- **Battle Damage**
  - Explosions, Burning

John Eicke, 301-394-2620

What Do We Want To Know ?

- Target location
- Target track of moving targets
- Target classification
- Target identification
- Target condition

John Eicke, 301-394-2620

ARMY RESEARCH LABORATORY

What Can We Detect ?

- Acoustic Emissions
- Seismic Signatures
- Magnetic Signatures
- Visible Signatures
- IR Signatures
- RF Emissions
- Chemical Emissions

John Eicke, 301-394-2620

ARMY RESEARCH LABORATORY

Technical Barriers

- Low cost sensors
- Sensor fusion
- Communications
- Packaging in munitions
- Power Sources

John Eicke, 301-394-2620

ARMY RESEARCH LABORATORY

Acoustic / Seismic

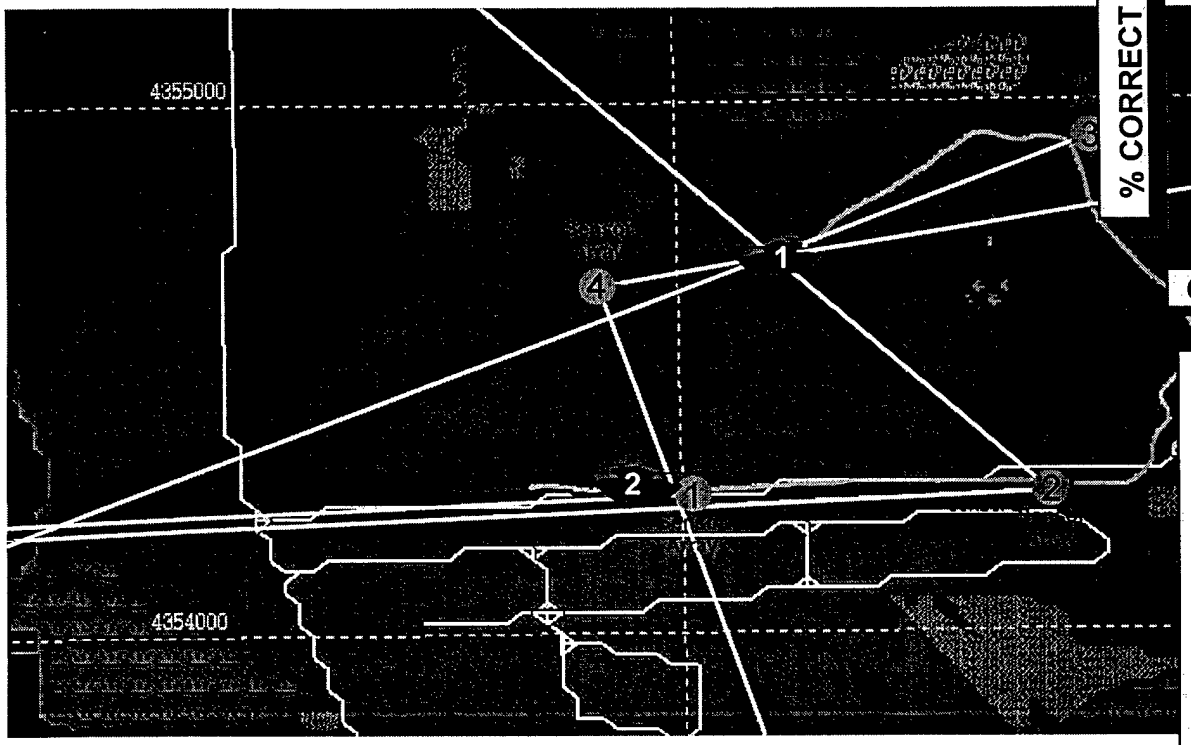
- **Sensors are:**
  - Passive
  - Low Cost
  - Non-Line of sight
  - 360 degree coverage
- **Shortcomings**
  - Greatly affected by atmospheric conditions
  - Relatively short range
- **Signal processing is advancing rapidly**
  - Generic processors & algorithms
  - Specific algorithms for battlefield sensors
- **Acoustic arrays can provide:**
  - LOB to target
  - Target classification / identification

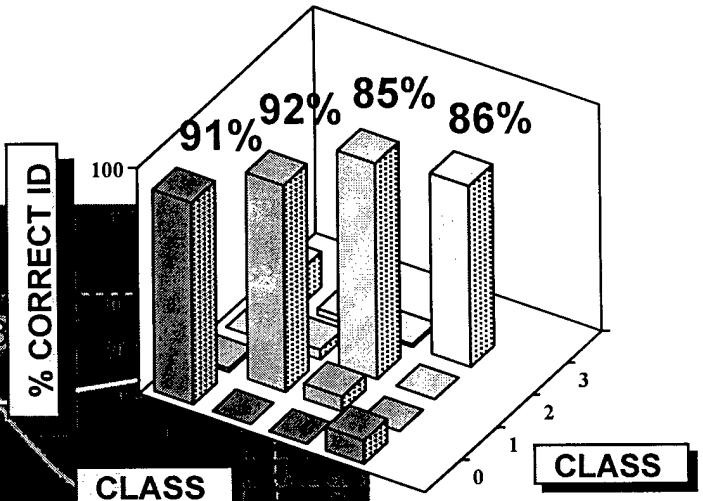
John Eicke, 301-394-2620

Acoustic Vehicle Detection

ARMY RESEARCH LABORATORY

Target tracking and identification



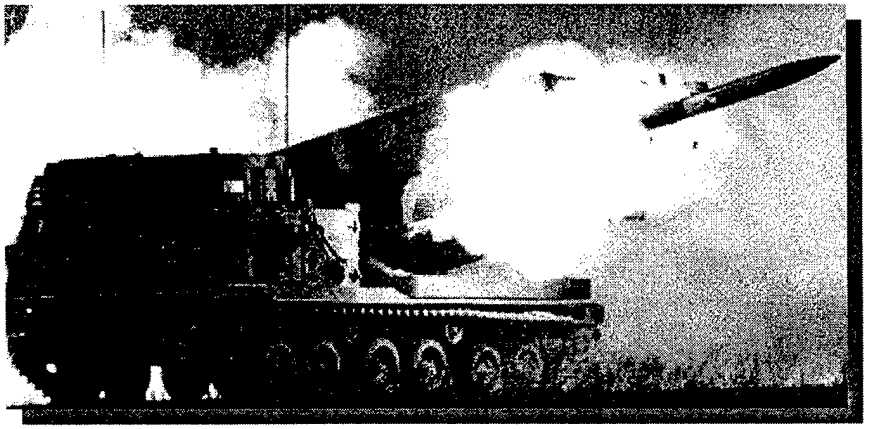


	0	1	2	3
0	90	0	0	10
1	1	92	6	0
2	0	4	96	0
3	15	2	1	80

John Eicke, 301-394-2620

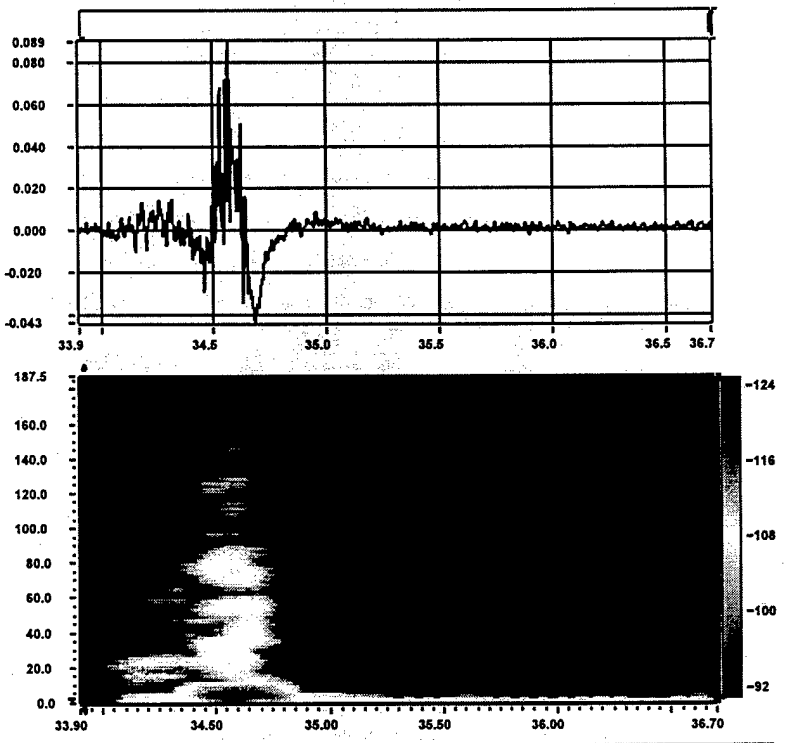
Acoustic Missile Launch Detection

ARMY RESEARCH LABORATORY



Infrasonic detection of missile launches and artillery fire provides a low cost, accurate, passive, detection and location capability

Infrasonic Target Location



Rocket Launch at 9 Kilometers

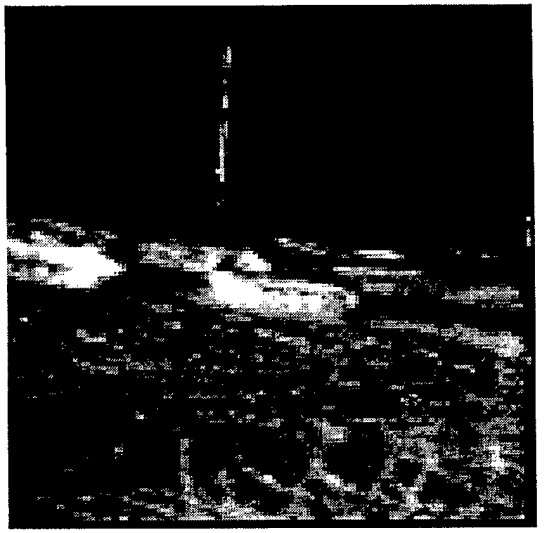
John Eicke, 301-394-2620

944

ARMY RESEARCH LABORATORY

Visible / IR

- **Sensors are:**
  - Passive
  - High resolution
  - Well suited to target identification
- **Shortcomings**
  - Relatively high cost
  - Affected by atmospheric conditions
  - Relatively short range
- **Signal processing is advancing**
  - ATR
  - Image stabilization
- **Imaging sensors can provide:**
  - LOB to target
  - Target classification / identification



John Eicke, 301-394-2620

ARMY RESEARCH LABORATORY

Magnetic

- **Sensors are:**
  - Passive
  - Very Low Cost
  - Non-Line of sight
  - 360 degree coverage
- **Shortcomings**
  - Very short range
  - Affected by any magnetic material
  - Immature for battlefield use
- **Magnetic sensors make good companions to other sensors to reduce false alarms**
- **Magnetics may be useful for detecting personnel at short range**

John Eicke, 301-394-2620

ARMY RESEARCH LABORATORY

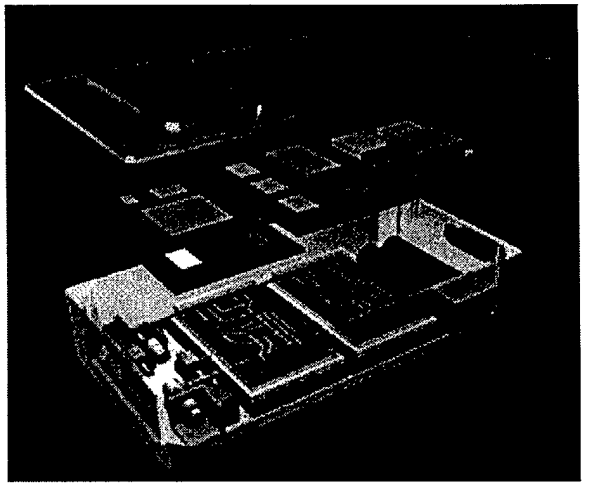
RF Sensors

- Sensors are:
  - Passive or active
  - Very Low Cost
  - Somewhat Non-Line of sight
  - 360 degree coverage
- Shortcomings
  - Short range
  - Wide range of interfering sources
  - Immature for battlefield use
- Active RF tripwire sensors are proven technology (prox fusing) but need to adapted to ground use
- Passive RF detection can provide useful information about aircraft and some ground targets

John Eicke, 301-394-2620

ARMY RESEARCH LABORATORY

Chemical



Sandia's "Lab on a Chip"

- **Sensors are:**
  - **Passive**
  - **Non-Line of sight**
  - **Potentially very small**
- **Shortcomings**
  - **Relatively short range**
  - **Greatly affected by atmospheric conditions**
  - **Immature for battlefield use**
- **Several programs are focused on small, modest performance detectors**
- **Chemical sensors can also provide vital clues for BDA**

John Eicke, 301-394-2620

ARMY RESEARCH LABORATORY

Sensor Fusion

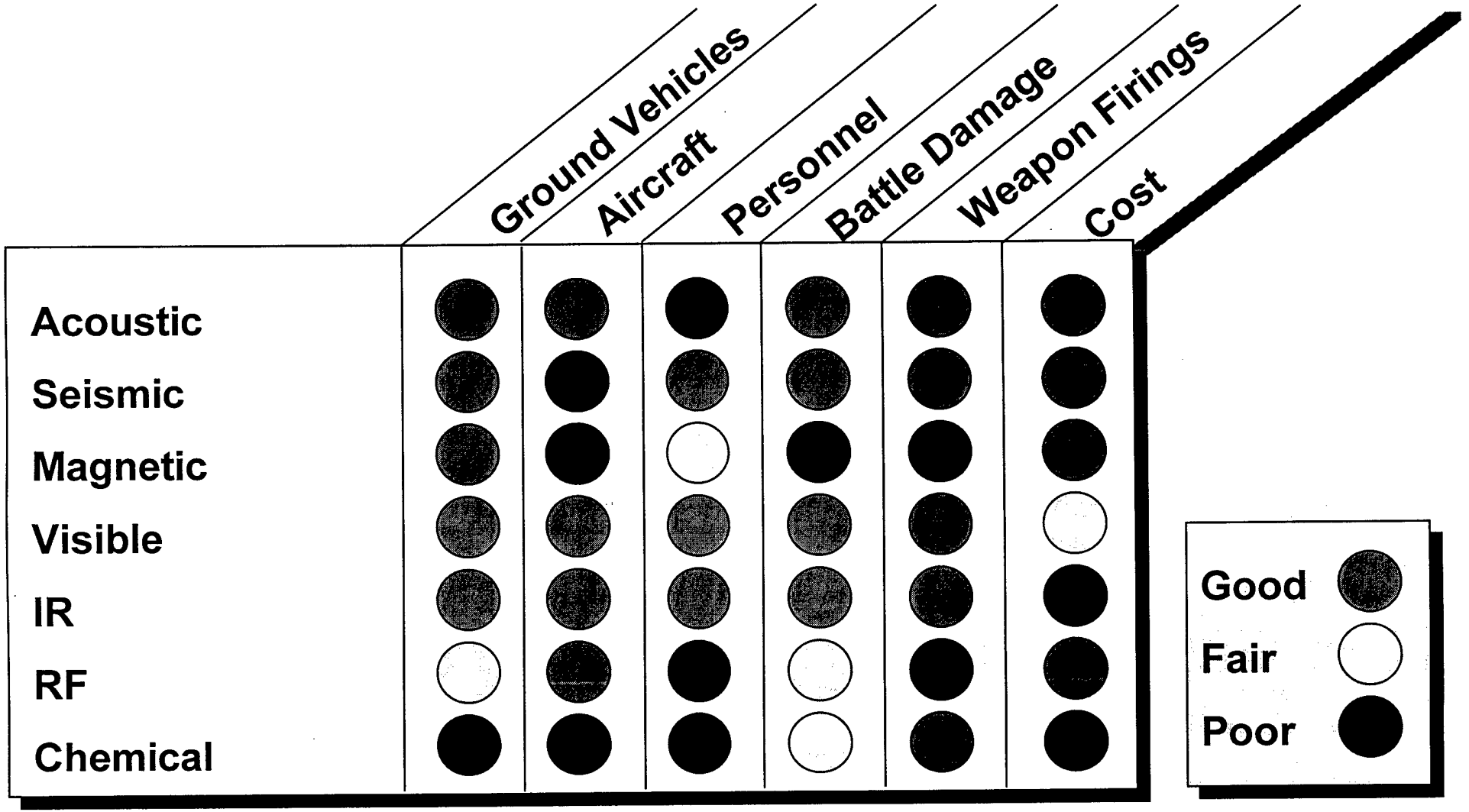
- **Sensor fusion is the key to real world performance**
  - **Multiple sensors inputs, each with modest information content, can be fused to provide a more accurate understanding of the target**
- **Multi-domain sensors provide highly orthogonal views of a target**
- **Some work is going on in low level sensor fusion**

If it looks like a tank, sounds like a tank, shakes the ground like a tank, smells like a tank, and is made of steel like a tank, - it might just be tank.

John Eicke, 301-394-2620

Sensor - Application Summary

ARMY RESEARCH LABORATORY

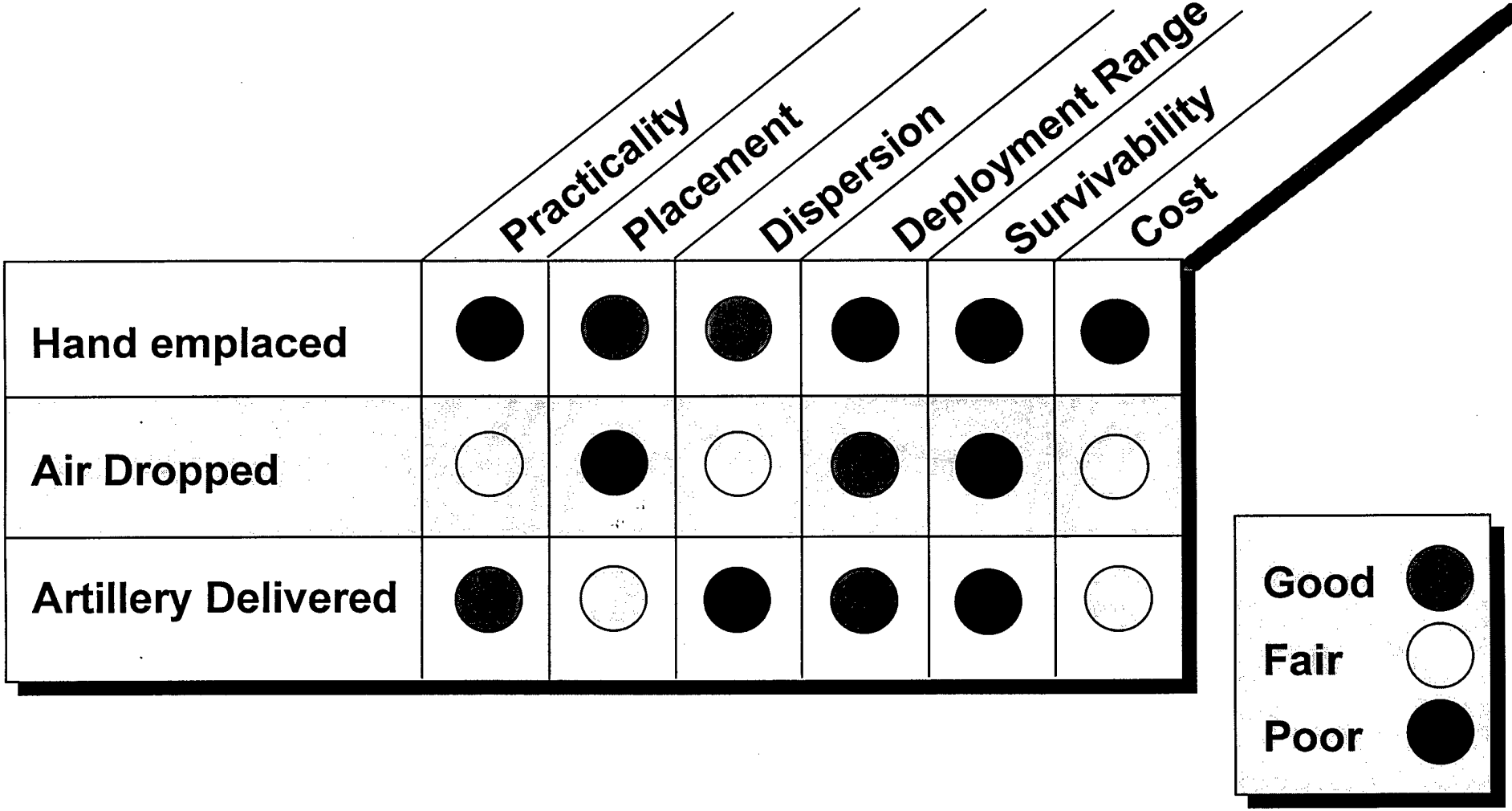


John Eicke, 301-394-2620

950

ARMY RESEARCH LABORATORY

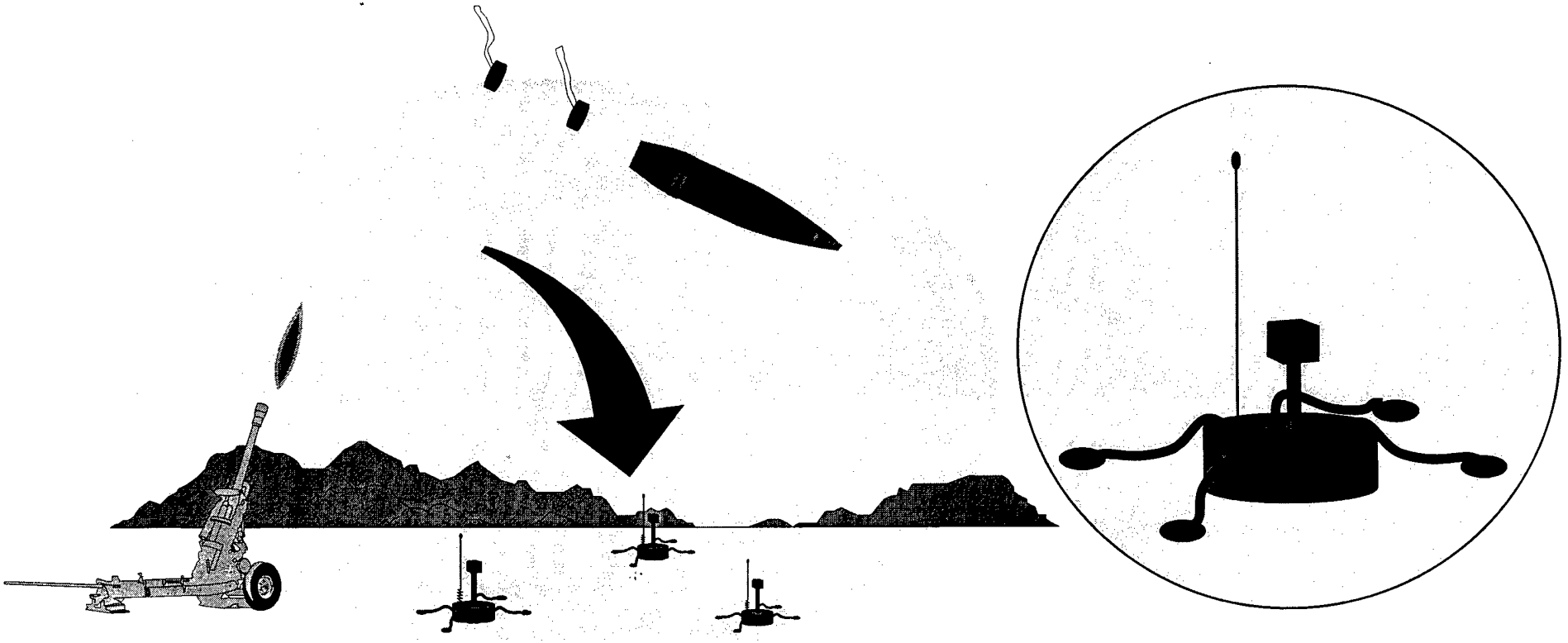
Sensor Emplacement



John Eicke, 301-394-2620

Artillery Delivered Sensor Concept

ARMY RESEARCH LABORATORY



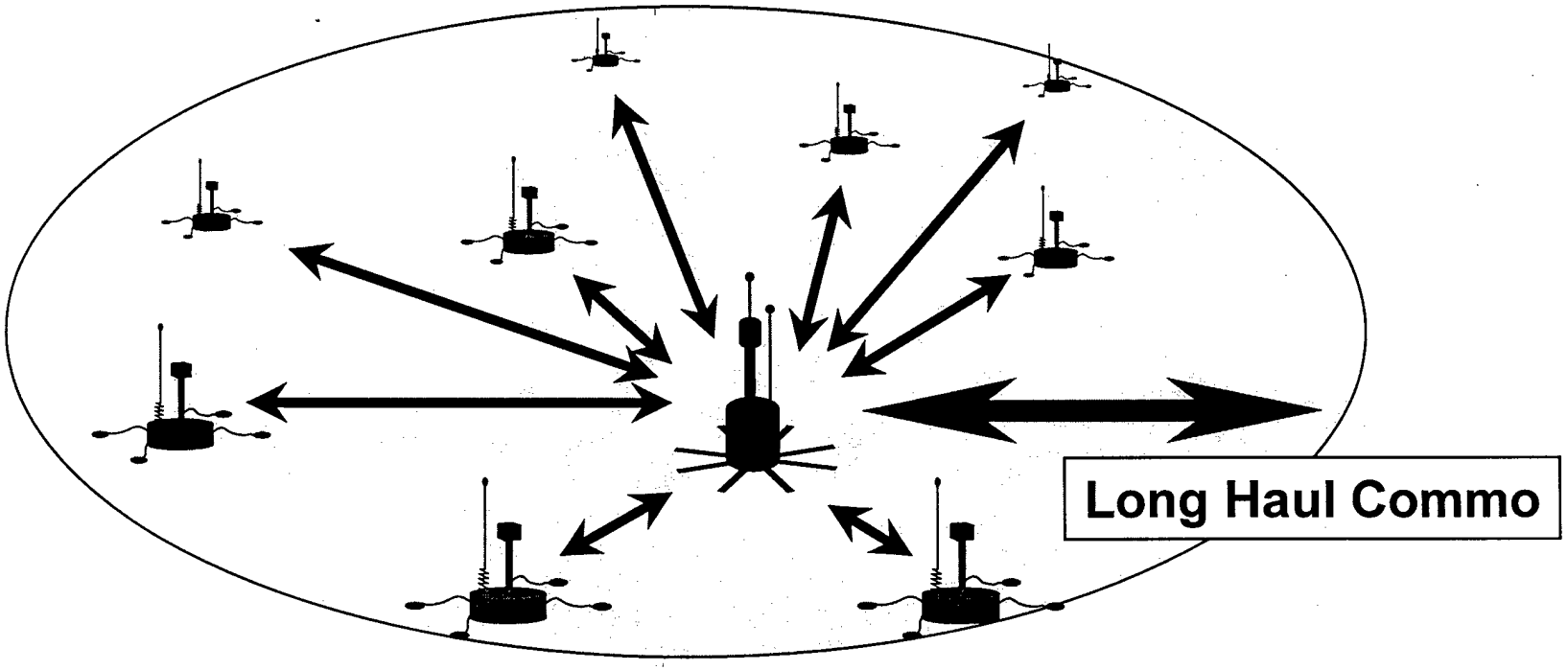
Sensors: Acoustic, seismic, magnetic, chemical imager
Commo: Local network, Long haul link to shooter
Life: 2-30 hours

John Eicke, 301-394-2620

952

ARMY RESEARCH LABORATORY

Sensor Network Operation



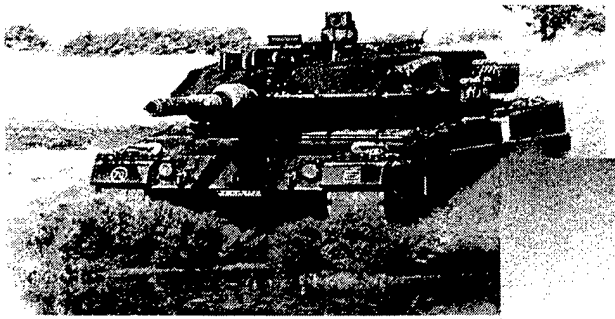
Sensor nodes communicate with a gateway.
Gateway fuses sensor inputs & controls sensor nodes.
Gateway provides long haul communications.

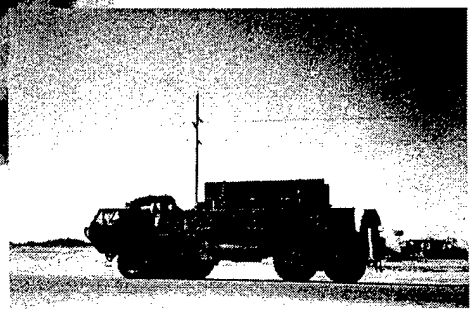
John Eicke, 301-394-2620

ARMY RESEARCH LABORATORY

Targets

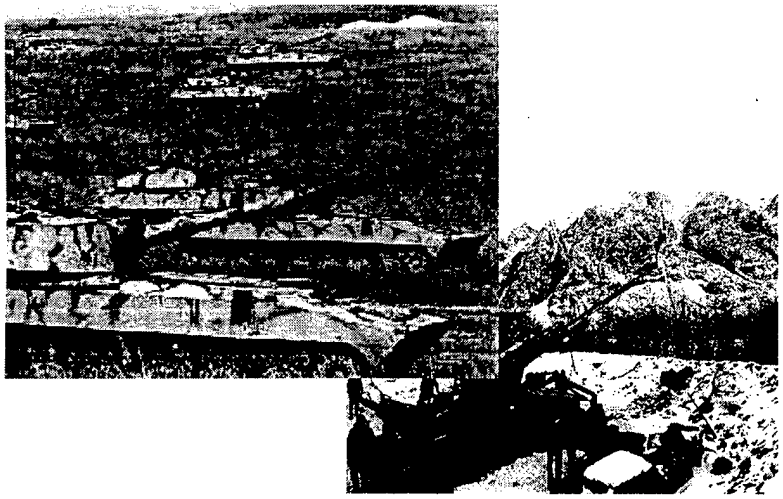
Battle Damage





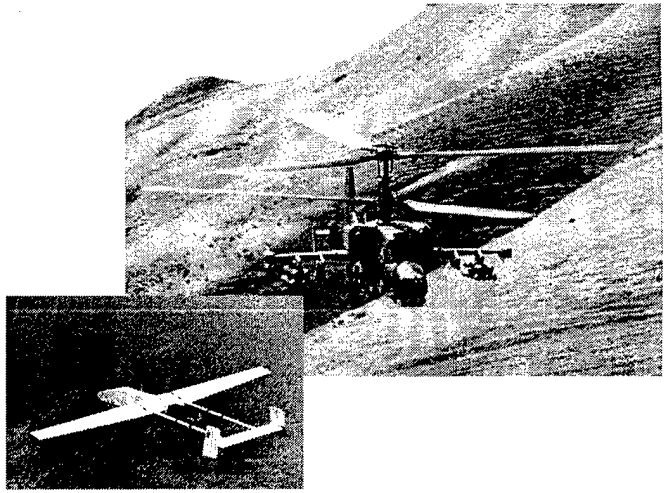
Ground Vehicles

Artillery



Personnel

Aircraft



John Eicke, 301-394-2620

954

Conclusions

- Indigenous target location, tracking, & identification capabilities are feasible for the field artillery
- Such a sensor network can also play a vital role in an overall area denial system
- Technology advances in the areas of sensors, sensor fusion, communications and power sources are key to overall system success
- There are a number of ongoing programs which are advancing key technology elements

John Eicke, 301-394-2620